

WHOLE LIFECYCLE INFORMATION FLOW UNDERPINNED BY BIM: TECHNOLOGY, PROCESS, POLICY AND PEOPLE

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Abstract: This paper explores the pillars that enable Whole Life Cycle (WLC) information in a construction enterprise. These identified as: technologies, processes, policy and people. WLC information flow is defined as the steady and continuous evolution and use of BIM information and knowledge from the design stage, through the construction stage, to the facility management stage. Enabling a WLC information flow requires the amalgamation of the four pillars (technologies, processes, policy and people) and should reduce inefficiencies associated with transiting information from one project phase to another.

This paper uses these four pillars to guide the analysis and comparison of the BIM status in two countries: the United Kingdom and Qatar. The BIM initiatives in the UK are reviewed from secondary data sources which are publicly available. The status of BIM in Qatar is obtained through the collection of primary data using interviews with industry players. The UK was selected as a benchmark country for Qatar due to the significant and centrally driven BIM strategy. The review and analysis of the BIM status in the two countries provide insights on how to enable a WLC information flow enabled by BIM technology, process, policy and people.

Keywords: BIM, whole life Cycle information, CAD, processes, Policy

1. FRAMEWORK FOR WHOLE LIFECYCLE INFORMATION FLOW

According to ISO12006-2, construction information is information used to support one or more construction processes (ISO, 2001). A construction process is a process which transforms construction resources into construction results. In this paper it is hypothesized that Lifecycle processes include:

- a) inception / design / production, this include creation of a construction entity from initial concept up to occupation by its users. Project stages might include inception, design, production information, tender, construction, commissioning.
- b) use / maintenance. This includes Maintenance/servicing of a construction entity over a given period. Project stages might include specification, tender, maintenance.
- c) refurbishment / alteration / re-commissioning, Project stages might include inception, design, production information, tender, construction, commissioning.
- d) decommissioning / demolition. Project stages might include documentation, tender, demolition

We consider lifecycle information flow enabled by BIM as a set of rules, represented graphically through process maps, or in writing, to enable the steady and continuous evolution and use of BIM information and knowledge from the design stage, through the construction stage, to the facility management stage, while reflecting the policies and being enabled by an adequate IT infrastructure. Such definition mostly agrees with the literature, defining building lifecycle information management as “the integrated coordination, organization and control of all of the information about a building project in advance of its design, construction and the day to day operation of the building until and including its demolition” (Riese, 2010). To further develop the subject area, this paper argues that a WLC flow is not only integration and coordination of information in design or construction processes but also most of the information/knowledge generated along the RIBA Plan of Work stages. One of the issues with construction project development stages is that information generated in previous stages, in some cases, has little value to the succeeding stage. This can cause information redundancy at every stage and ultimately leads to massive inefficiency. Figure 1 depicts this in a simplified way. As project development processes proceeds from one stage to another, information is lost in the transition. The ultimate goal in the WLC information flow concept is to minimize or eliminate information loss, achieve efficiency by re-using the information and adding value to it when it is transited from one stage to another (this is depicted by the red line in Figure 1).

For the purpose of this paper we will consider building lifecycle information management ending with the operational phase of building construction entities in accordance with the RIBA plan of work stage 7 (RIBA, 2013).

This is an important distinction to some other approaches, e.g. building Life Cycle Assessment (LCA) which considers ‘cradle-to-grave’ building lifespan, lasting often more than 50 years (Kotaji et al., 2003). LCA would thus consider waste treatment as part of the building life consisting of the following phases: design, construction, operation, demolition and waste treatment. Other approaches are also found in literature. For

example, whole life cycle building energy performance analysis would distinguish only 4 stages: preparation (manufacture and transport), construction, maintenance and demolition (Deng et al., 2014).

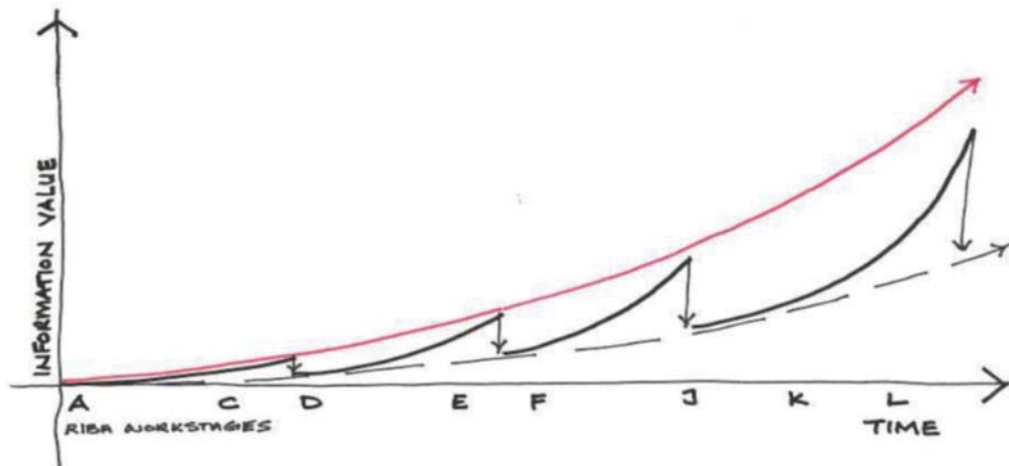


Figure 1. Information value is lost in the transition between building project work stages

In this context the aim of this paper is to introduce and discuss a framework that enables the whole lifecycle information flow underpinned by BIM. The framework is composed of four pillars: processes, technology, policy and people. These are developed concurrently and are highly dependent on each other. Figure 2 shows the processes embedded in each of these pillars.

The technology pillar consists of a classification of BIM technologies, according to their functions such as: design, analysis, management and review technologies. The mapping of technologies onto project processes should assist in linking BIM deliverables to suitable BIM technologies and interoperability requirements. Technologies can include:

- Identify detailed functionalities needed: this to include design, programme, analysis, manage and review.
- Map current available tools onto the functionalities identified and create technology diagram and where possible identify data exchange/interoperability.
- Create detailed protocol manual that will include detailed instructions about setting up a collaboration server, model sharing rules, modelling instruction for each functionalities.
- Provide training and continuous assessment.

The process pillar includes identifying and standardising different work streams for each RIBA stage and their interactions with different RIBA stages and supply chain roles and responsibilities. The processes include:

- Identify work streams and provide standards/manuals for each stream. For example, design authoring, cost estimation and control, planning and building regulation approvals, energy assessment and calculation, construction planning and monitoring control, etc. Work streams to be mapped onto RIBA stages of work.
- Establish level of details (LOD) and level of information (LOI) for each process and in each stage. AIA standards are to be adopted and used in a formalised way.
- Document processes using different presentation format and templates to facilitate adoption.
- The policy pillar shows a number of processes that needs to be developed at project, company, sector, regional and country levels. These processes include:

- Establish modelling standard, this can include adoption of BS 1192:2007 or other related available standards.
- Contractual arrangements and the use of standard forms of agreement related to model or 'partial' model ownership. Also, this will include identify roles and responsibilities of developing and re-using information. This is of particular importance as adding value to information produced in proceeding processes should assume that information is accurate and the new value to be added is the responsibility of the actor 'or a person' who contributes to this.

The final pillar is people issue which is one of the important elements of the policy. This pillar includes training, competency assessment standards for both, people and organisations, leadership, teamwork and others. The people pillar cuts across all three other pillars, as technology, processes and policy will not operate properly unless well-trained and developed human resource are available.

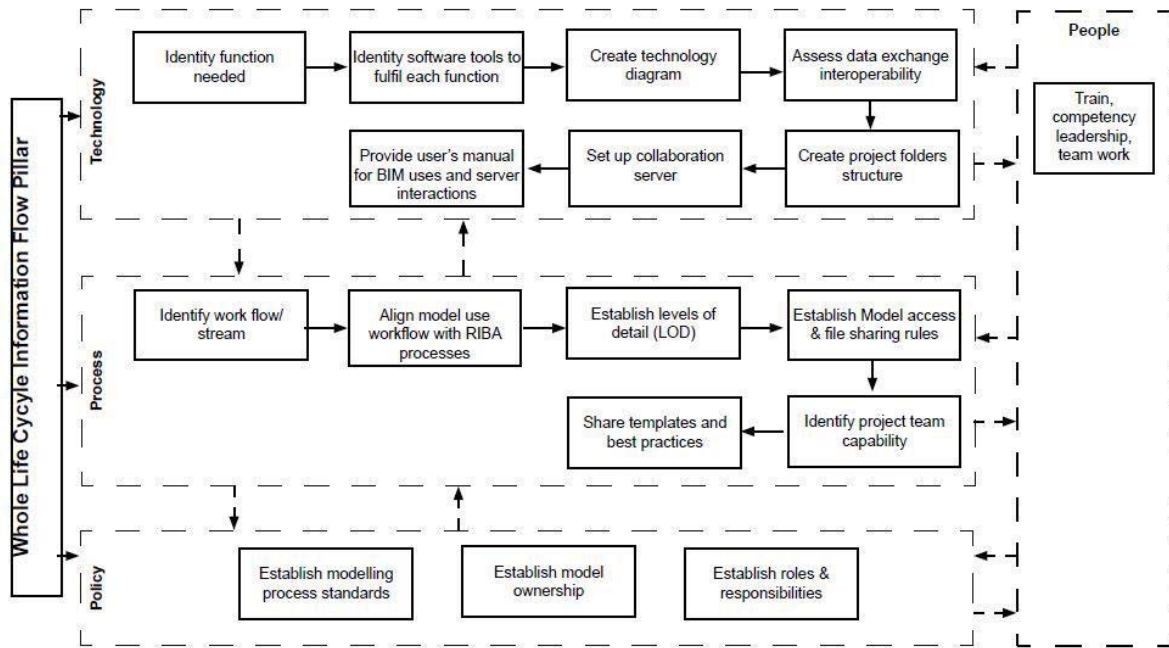


Figure 2. The four pillars of Whole Life Cycle information Flow.

2. THE UK CASE OF ADOPTION WLC UNERPINNED BY BIM

The United Kingdom has been active in developing whole life cycle information flow strategies and BIM policies for improving the performance of its construction industry. In May 2011, the UK Government published its “Government Construction Strategy” which emphasized the need to develop standards for enabling all members of the supply chain to work collaboratively through BIM. The strategy also announced that the “Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016”.

UK BIM government strategy is based on 7 elements and some of these have been already delivered:

- PAS 1192-2:2013 *Specification for information management for the capital/delivery phase of assets using building information modelling* (see Figure 3)
- PAS 1192-3:2014 *Specification for information management for the operational phase of assets using building information modelling*.
- BS 1192-4 Collaborative production of information. Part 4: Fulfilling employers’ information exchange requirements using COBie – Code of practice.
- Building Information Model (BIM) Protocol
- GSL (Government Soft Landings). FM requirements embedded and incorporated in BIM.
- Digital Plan of Work: Defines information requirements aligned to specific project stages. It follows a reference library of definition templates describing the typical level of definition for different stages of a project consistent with the unified classification system Uniclass 2015.
- Classification (Uniclass 2015): Uniclass is a voluntary classification system for the construction industry that can be used to organise information throughout all aspects of the design and construction process. Adopting a standard classification facilitates interoperability between different systems

A “BIM Task Group” bringing together the expertise from industry, government, public sector, institutes and academia, was formed and tasked to deliver the Government strategy. The first version of the UK BIM guidelines was then developed and released in 2013 and identified three major milestones (called maturity levels) for industry to aim for: Level 1 (2d/3D CAD file based collaboration), Level 2 (BIM file based collaboration), and Level 3 (fully open and integrated web service environment). These milestones have been depicted in Figure 4. The three levels are shown with their related British standards and protocols. Task Group then went on to mandate deliverables to be at Level 2 by 2016. Compared to Singapore which mandated Level 3 UK-equivalent by 2015, the UK strategy seems much less ambitious. However, this phased approach to BIM implementation - recommended by a Strategy Paper to the Government Construction Client Group- actually reflects how most UK firms are still at Level 1.

The levels considered by the UK strategy are:

- Level 0: Unmanaged CAD probably 2D, with paper (or electronic paper) as the most likely data exchange mechanism.
- Level 1: Managed CAD in 2 or 3D format using BS 1192:2007 with a collaboration tool providing a common data environment, possibly some standard data structures and formats. Commercial data managed by standalone finance and cost management packages with no integration.
- Level 2: Managed 3D environment held in separate discipline “BIM” tools with attached data. Commercial data managed by an ERP. Integration on the basis of proprietary interfaces or bespoke middleware could be regarded as “pBIM” (proprietary). The approach may utilise 4D Programme data and 5D cost elements.
- Level 3: Fully open process and data integration enabled by IFC / IFD. Managed by a collaborative model server. Could be regarded as iBIM or integrated BIM potentially employing concurrent engineering processes

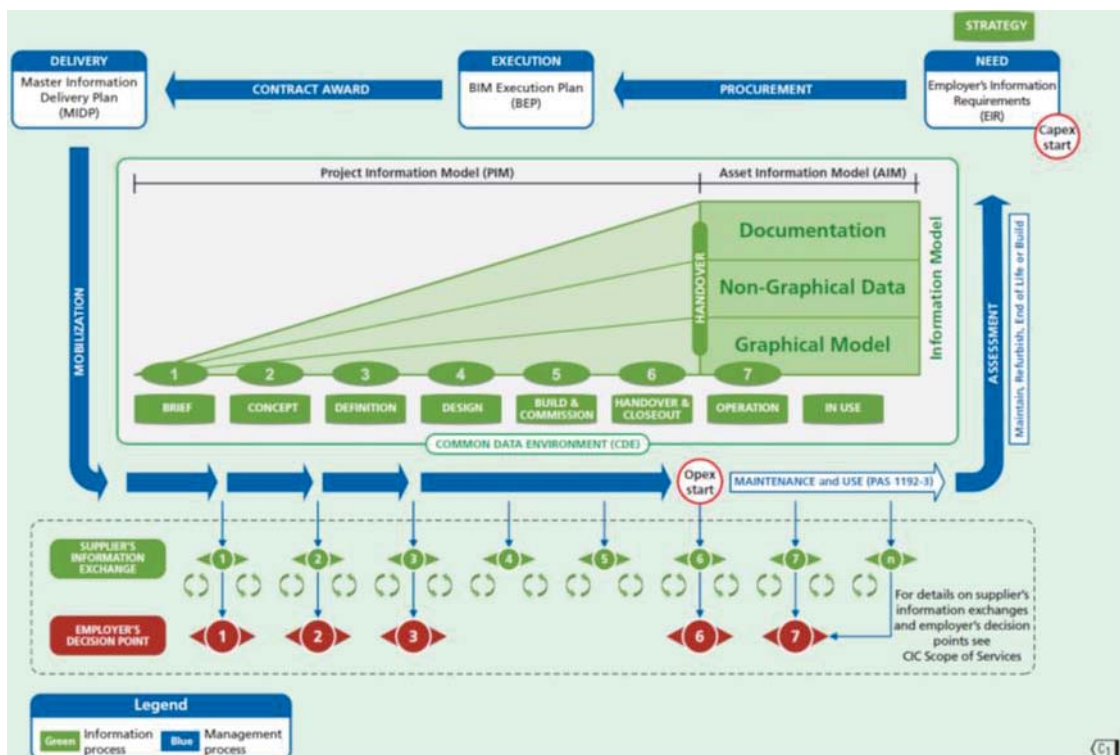


Figure 3. Building lifecycle information delivery as defined in PAS 1192-2 (BSI, 2013)

In addition to the publications sponsored/released by the UK government and BSI, industry associations are also playing a significant role in releasing NBPs. For example, the Royal Institute of British Architects (RIBA) has updated their popular RIBA ‘Outline Plan of Work’ to include a ‘BIM Overlay’ (RIBA, 2012) reflecting the changes BIM introduces to different project phases.

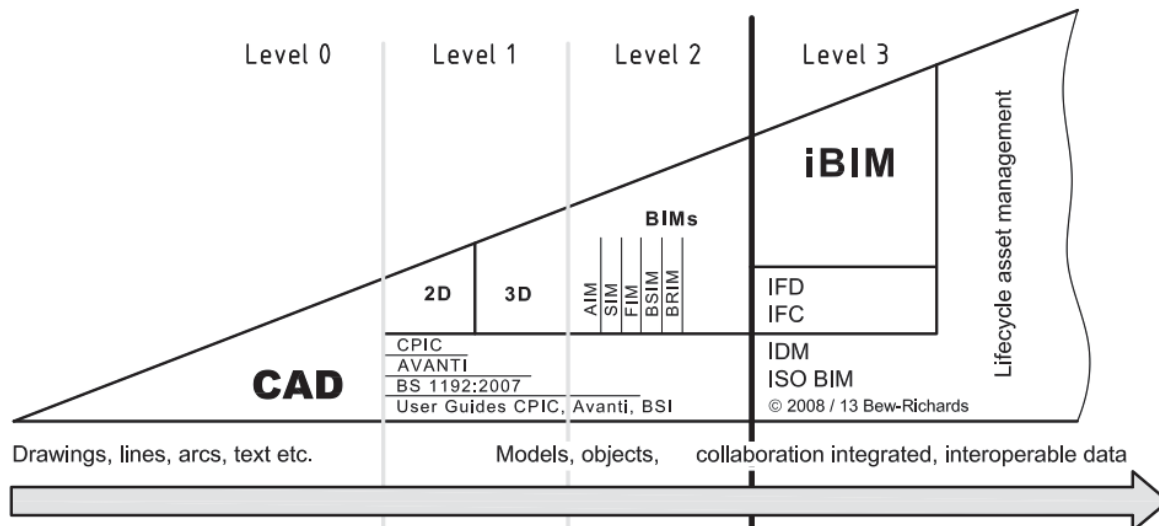


Figure 4. UK government three milestone levels (UK BIM task force)

3. THE CASE OF QATAR

The construction industry in Qatar, similarly to the European and American construction industries, is not immune to delays and cost overruns. Al Jurf and Beheiry (2010) interviewed 15 grade 'A' contractors operating in Qatar and found out that time and cost overruns are not unusual on both small and large projects. Qatar is expecting to witness tremendous growth following their winning bid to host the FIFA World Cup in 2022. According to a five-year forecast by Ventures Middle East, Qatar's construction sector which contributes 7.2 per cent to the economy (2009), is expected to spend around \$100 billion on construction projects in the next four years (IQPC, 2011). Therefore, the possibility of savings on such a large volume of construction is enormous. In addition to the savings that can be achieved through the implementation of BIM, new scenarios comparing design alternatives for various aspects such as buildability, sustainability, structural, spatial configuration can be enabled with BIM. This matches fully with the current needs of Qatar. For example, with regards to sustainability, the need for sustainable and green building solutions in Qatar has never been greater than it is today according to the Qatar National Vision 2030 (MDPS, 2013); as such Qatar's construction industry is looking for technologies and techniques that can enable more sustainable practices. A recent BIM survey conducted in Middle East (including Qatar) by buildingSMART showed that the BIM usage is around 25% and the level of competency is underdeveloped compared to regions such as Western Europe (BS, 2011). The authors of this paper are embarking on a major research project funded by Qatar Foundation to develop whole life cycle information protocols for Qatar construction industry. The project is at an early phase and early results showed that there are major developments needed in processes, policies and people. The developed framework shown in figure 2 has been used to bench-mark current practices in Qatar construction industry. The following sections briefly outline current practices in the four pillars of whole life cycle information flow based on 15 semi structured interviews with industrial leaders in Doha. This survey is continuing to identify a framework and processes that can fit the needs for Qatari construction industry.

3.1 Policy

Project Delivery methods: The commonly used project delivery methods are traditional DBB (design bid build) and DB (design and build). The use of Design and Build approach on projects varies from project to project. An adapted state of Design and Build project delivery method was being used on a complex project and this adapted state was named as Design-Development-Project. The project delivery in this method is done in such a way that partial design is completed by the designer and given to the contractor to develop it further and then execute it in construction.

Information standard: Based on the interviews, the BIM standards that are being used are mostly UK standards and US standards. BS 1192:2007, AEC (UK) BIM Protocol and BIM standards and guidelines from AIA are some common examples.

When asked about the need for BIM standards for Qatar, majority of interviewees agree that there is a need to develop BIM standards for Qatar keeping in view the on-going and future construction projects that are planned for Qatar. The use of different standards on different projects may act as a barrier to adoption of BIM for Qatar Construction Industry.

BIM requirement for projects: While BIM is being increasingly required in the projects, the BIM requirements are deemed inconsistent by some interviewees. Part of the reason for this inconsistency could be lack of understanding of BIM from the clients/owners who define information requirements for the projects. Use of different BIM standards could also be a reason for this inconsistency of requirements.

The interviews have revealed that evaluation of BIM competency of designers and contractors is mainly done based on past experience with BIM enabled projects. Some weighting is given to the BIM competency either in prequalification or bid evaluation. This weighting coupled with other criteria (including both Technical and Financial) forms the basis for selection.

The contract documents usually mention the Level of Detail (LoD) for BIM model required from designers and contractors at various stages of project but interviewees indicated issues related to practicability of such requirements. The reason is that in most cases there is no clear plan set for facilities management about the ways the client/owner intends to use the model.

3.2 People

Almost all the interviewees agree on the 'Lack of in-house expertise' being one of the barriers to BIM adoption in Qatar. They further agree on the need for training people on BIM specific positions e.g. BIM Manager, as well as providing BIM training to people who are not working on any BIM specific position.

The contract usually mentions some BIM specific positions and puts relevant experience as a requirement for people on such positions. However the interviewees indicate that it is not easy to find people complying with such requirements.

When asked whether they (interviewees) have experienced any requirements of certifications with respect to BIM, the common answer is that there are no standard certifications for BIM so far which have gained acceptance in the construction industry in Qatar.

3.3 Process

When asked about the use of project stages, no standard project stages, e.g. RIBA work stages (RIBA, 2013), were identified. The clients tend to divide project requirements subject to their convenience. However, when asked about the need for standardization of the project stages, most interviewees suggested that standardized project stages along with clear deliverables and process maps in each stage would be needed to allow better communication among the stakeholders.

3.4 Technology

The respondents did not report major short comings in technology compared to other BIM fields. However, certain BIM tools have limitations when it comes to complex architecture and curves. In addition, most interviewees report that the IFC exchange format caused data loss and distortion of geometry when used to export the BIM model.

4. CONCLUSIONS

The aim of this paper was to define a whole life cycle information flow in the context of construction processes. Four pillars that need to be developed concurrently to facilitate a proper and efficient flow of information from one phase to another of construction processes are explored. The case for both UK and Qatar has been identified and discussed.

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